
Phylloscirpus (Cyperaceae) Revisited

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ABSTRACT. Two species of *Scirpus* are transferred to *Phylloscirpus*: *Scirpus deserticola* Philippi and *Scirpus boliviensis* Barros. *Phylloscirpus deserticola* has all the typical characteristics of the genus *Phylloscirpus*, such as eligulate leaves, a terminal head of spikelets, and scabrid hypogynous bristles. The allocation of *Scirpus boliviensis* to *Phylloscirpus* is morphologically less obvious due to its reduced structures, but is well supported by a phylogenetic analysis based on plastid *rbcL* and *trnL-F* sequence data. *Phylloscirpus deserticola* is lectotypified because the holotype consists of a mixed collection.

Key words: Andes, Cyperaceae, *Phylloscirpus*.

Phylloscirpus C. B. Clarke (1908) is a genus with a single species, *Phylloscirpus acaulis* (Philippi) Goetghebeur & D. A. Simpson (1990), distributed in Andean regions of South America. Clarke (1908) described the genus based on the presence of a dense head of spikelets subtended by bracts, each spikelet having spirally arranged glumes and bisexual flowers comprising five or six scabrid, hypogynous bristles.

During our ongoing taxonomic study of *Scirpus* s.l. in the Andes, it became clear that one of the species, *Scirpus deserticola* Philippi, clearly has the diagnostic features of *Phylloscirpus*, justifying a new combination within the genus. Another and very small species, *Scirpus boliviensis* Barros, also has characters in common with the species of *Phylloscirpus*, such as eligulate leaves and numerous red tannin idioblasts in the glumes. Although Clarke did not mention these characters in his original description, our observations and a molecular analysis discussed below strongly indicate that *Scirpus boliviensis* Barros should be included in the genus *Phylloscirpus*. However, as *Scirpus boliviensis* Barros has one terminal spikelet (opposed to a head of spikelets) and no bristle hairs, it is necessary to redefine *Phylloscirpus*, to give the genus a broader circumscription.

This proposal to make two new combinations in *Phylloscirpus* is well supported by our phylogenetic analysis based on *rbcL* and *trnL-F* sequencing data of several Andean *Scirpus* species.

MATERIAL AND METHODS

MORPHOLOGICAL DATA

Morphological data were obtained from the study of herbarium material with a stereomicroscope. Herbarium material from the following herbaria was studied: AAU, B, BM, C, GENT, GH, GOET, ISC, K, NY, P, QCA, SGO, SI, U, and US.

MOLECULAR DATA

The plant material used for DNA extraction and its provenance are listed in Table 1. Total DNA was isolated using the modified CTAB method of Doyle and Doyle (1987). Amplification was done in overlapping pieces using the 1F, 1024F, 724R, 1024R, and 1460R primers for the *rbcL* gene (Muasya et al., 1998) and the c, d, e, and f primers for *trnL-F* (Taberlet et al., 1991). The amplified products were cleaned using the QIAquick Kit according to the manufacturer's protocols (Qiagen, Ltd.), and sequenced using standard dideoxy methods and run on an ABI 377 automated sequencer (all according to the manufacturer's protocols, Applied Biosystems, Inc.). The sequences were edited in Sequence Navigator, assembled in Autoassembler (Applied Biosystems, Inc.), and aligned by eye in a sequence matrix of *Scirpus* s.l. (Muasya et al., 2000).

PHYLOGENETIC ANALYSIS

The molecular data set was analyzed using parsimony algorithms of PAUP* 4.0b8 (Swofford, 2002). A heuristic search of 1000 replicates with the TBR (tree-bisection-reconnection) swapping algorithm and random addition was conducted, retaining five trees at each step. Internal support was estimated with 1000 bootstrap replicates. For each bootstrap replicate, 100 heuristic searches with random sequence addition were conducted.

TAXONOMY

Phylloscirpus deserticola (Philippi) Dhooge & Goetghebeur, comb. nov. Basionym: *Scirpus deserticola* Philippi, Fl. Atacam.: 53. 1860. TYPE: Chile. Agua de profetas in deserto Atacamensi, Jan. 1854, R. A. Philippi s.n. (lectotype, selected here, SGO 046286 A). Figure 1A, D.

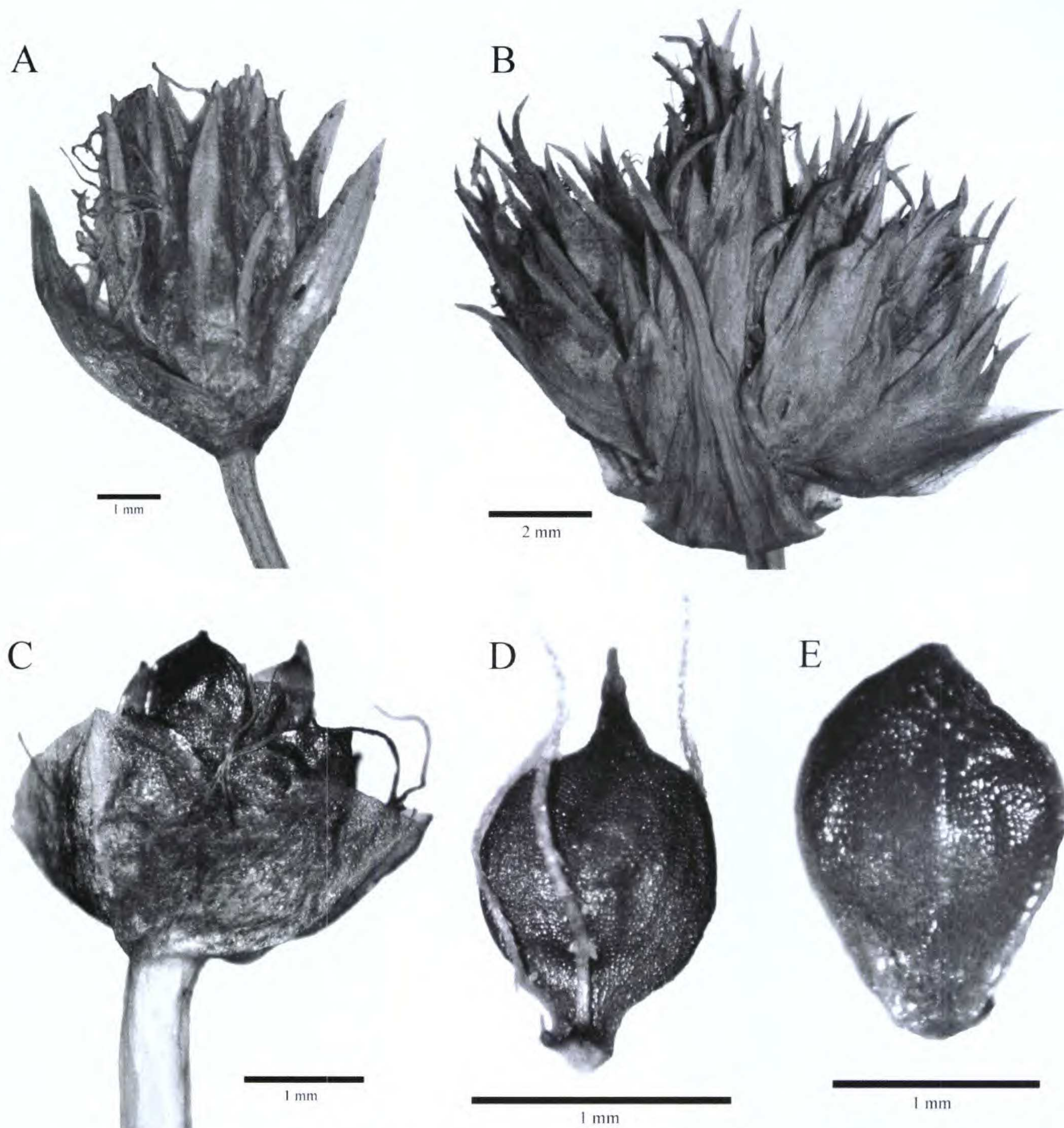


Figure 1. A and D. *Phylloscirpus deserticola* (Philippi) Dhooge & Goetghebeur (*Philippi s.n.*, lectotype, SGO). —A. Inflorescence. —D. Fruit with bristle hairs. —B. Inflorescence of *Phylloscirpus acaulis* (Philippi) Goetghebeur & D. A. Simpson (*Ruthsatz 8765*, GENT). C and E. *Phylloscirpus boliviensis* (Barros) Dhooge & Goetghebeur (*Petersen & Hjerting 1043b*, holotype, C). —C. Inflorescence. —E. Fruit.

Scirpus semisubterraneus Boeckeler, *Linnaea* 36: 495. 1870. *Scirpus deserticola* Philippi var. *semisubterraneus* (Boeckeler) Barros, *Anal. Mus. Argent. Cienc. Nat.* 38: 156. 1935. TYPE: Peru. W. Lechler n° 1977 (holotype, not seen; isotypes, K, P).

Caespitose, small herbs, 1.8–12 cm tall; rhizomes creeping, branching; culms 0.6–10 cm × 0.5–1.3 mm, terete, glabrous, sometimes with little red spots (tannin idioblasts), covered with old brown leaf sheaths. Leaves shorter than to as long as the culm; leaf sheaths 2.5–6.5 mm long, often with red spots; leaf blade 0.3–1.9 cm × 0.4–0.85 mm, scabrous toward the leaf tip; leaf tip muticous,

often orange; ligule absent. Inflorescence a single spikelet or a terminal, dense head composed of 2 to 6 spikelets (Fig. 1A), 4–7.2 × 1.5–8 mm, red-brown to dark brown; when 2 or more spikelets are present, each lateral spikelet subtended by a bract and a small, membranous prophyll; bracts 3.4–6.5 × 2–4 mm, red-brown with many tannin idioblasts and a conspicuous, swollen, pale midrib, apiculate, as long as to slightly shorter than the inflorescence. All glumes fertile, 2.7–4.7 × 1.5–1.9 mm, ovate, red-brown with many red spots (tannin idioblasts) and a conspicuous, swollen, pale midrib; flowers bisexual; stamens 3; ovary 3-carpellate; style

Table 1. Taxa from Cyperaceae analyzed in the combined *rbcL-trnL-F* study. Literature citations are given for previously published sequences.

Taxon	Source/Voucher	Provenance	<i>rbcL</i>	<i>trnL-F</i> intron, exon & spacer	<i>trnL-trnF</i> intron	<i>trnL-F</i> exon & spacer
<i>Actinoscirpus grossus</i> (L.f.) Goetghebeur & D. A. Simpson	Muasya et al. (1998)	Malaysia	Y12953		AJ295765	AJ577319
<i>Ascolepis capensis</i> (Kunth) Ridley	Muasya et al. (1998)	Kenya	Y13003		AJ295757	AY040594
<i>Blysmus compressus</i> Panzer	Muasya et al. (2000a)	Afghanistan	AJ404700		AJ295766	AJ577320
<i>Cyperus papyrus</i> L.	Muasya et al. (1998)	Chad	Y12966		AJ295759	AJ577321
<i>Eriophorum angustifolium</i> Honck- eny	Muasya et al. (2000a)	Ireland	—	AJ577335		
<i>Eriophorum vaginatum</i> L.	Muasya et al. (1998)	Poland	Y12951		AJ295769	AJ577322
<i>Fimbristylis dichotoma</i> (L.) Vahl	Muasya et al. (1998)	Kenya	Y13008		AJ295755	AJ577323
<i>Helmuthia membranacea</i> (Thun- berg) R. W. Haines & Lye	Muasya et al. (1998)	South Africa	Y13000		AJ295815	AJ577324
<i>Hypolytrum nemorum</i> (Vahl) Sprengel	Muasya et al. (1998)	Malaysia	Y12958		AJ295816	AJ577325
<i>Isolepis hystrix</i> (Thunberg) Nees	Muasya et al. (2000a)	South Africa	AJ404711		AJ295785	AJ577326
<i>Isolepis setacea</i> (L.) R. Brown	Muasya et al. (1998)	Kenya	Y12962		AJ295799	AJ577327
<i>Kyllingiella microcephala</i> (Steu- del) R. W. Haines & Lye	Muasya et al. (2000a)	Zimbabwe	AY040592		AJ295807	AJ577328
<i>Kyllingiella polyphylla</i> (A. Rich- ard) Lye	Muasya et al. (1998)	Tanzania	Y13013	AJ297515		
<i>Mapania cuspidata</i> (Miquel) Uit- tien	Muasya et al. (1998)	Brunei	Y12955		AJ295817	AJ577329
<i>Oreobolopsis tepalifera</i> T. Koyama & Guaglianone	Læggaard et al. 21493 (AAU, GENT, QCA)	Ecuador	AJ575932	AJ576035		
<i>Phylloscirpus acaulis</i> (Philippi) Goetghebeur & D. A. Simpson	Ruthsatz 9341 (GENT, TRIER)	Argentina	AJ575926	AJ576029		
<i>Phylloscirpus boliviensis</i> (Barros) Dhooge & Goetghebeur	Læggaard 102805 (AAU, GENT)	Ecuador	AJ566081	AJ566082		
<i>Phylloscirpus deserticola</i> (Philippi) Dhooge & Goetghebeur 01	Læggaard 21478 (AAU, GENT, QCA)	Ecuador	5' AJ704783 3' AJ704784	AJ704786		
<i>Phylloscirpus deserticola</i> (Philippi) Dhooge & Goetghebeur 02	Beck 21816 (GENT)	Bolivia	AJ704785	AJ704787		
<i>Phylloscirpus deserticola</i> (Philippi) Dhooge & Goetghebeur 03	Ruthsatz 8304 (GENT, TRIER)	Chile	5' AJ575925 3' AJ575935	AJ576028		
<i>Pycneus flavescens</i> (L.) Reichen- bach	Muasya et al. (1998)	Kenya	Y13005		AJ295763	AJ577330

Table 1. Continued.

Taxon	Source/Voucher	Provenance	<i>rbcL</i>	<i>trnL-F</i> intron, exon & spacer	<i>trnL-trnF</i> intron	<i>trnL-F</i> exon & spacer
<i>Schoenoplectus lacustris</i> (L.) Palla	Muasya et al. (1998)	Britain	Y12943		AJ295809	AJ577331
<i>Schoenoplectus pungens</i> (Vahl) Palla	<i>Mac Gregor 15733</i> (K)	USA, Kansas	—		AJ577336	—
<i>Schoenus nigricans</i> L.	Muasya et al. (1998)	Arabia	Y12983		AJ295814	AJ577332
<i>Scirpoides holoschoenus</i> (L.) Soják	Muasya et al. (1998)	South Africa	Y12994		AJ295811	—
<i>Scirpus polystachyus</i> F. Mueller	Muasya et al. (1998)	Australia	Y12974		AJ25813	AJ577333
<i>Trichophorum cespitosum</i> (L.) Hartman	Muasya et al. (1998)	British Isles	Y12969			
<i>Trichophorum rigidum</i> (Steudel) Goetghebeur, Muasya & D. A. Simpson	Muasya et al. (2000a)	Argentina	AJ297509		AJ295808	AJ577334
<i>Zameioscirpus atacamensis</i> (Philippi) Dhooge & Goetghebeur	<i>Ruthsatz 9884</i> (TRIER, US)	Argentina	AJ575929	AJ576032		
<i>Zameioscirpus gaimardioides</i> (E. Desvaux) Dhooge & Goetghebeur	<i>Ruthsatz 9676</i> (TRIER, US)	Argentina	5' AJ575928 3' AJ575938	AJ576031		
<i>Zameioscirpus muticus</i> Dhooge & Goetghebeur	<i>Ruthsatz 9212</i> (GENT, TRIER)	Argentina	AJ575927	AJ576030		

branches 3; perianth segments 3 to 6, bristle-like, shorter to somewhat longer than the fruit, retrorsely scabrous. Fruit 1.1–1.7 × 0.6–0.9 mm, ovate, rounded trigonous in cross section, brown with a reticulate surface and black remnant of the style base; basal part of the fruit constricted (Fig. 1D).

Habitat and distribution. In páramo or puna vegetations at elevations of 3200–4830 m from Argentina, Bolivia, Chile, Ecuador, and Peru.

Phenology. Flowering year round (pers. obs.).

The holotype sheet of *Scirpus deserticola* Philippi (SGO 046286) is a mixture of *Phylloscirpus deserticola* with *Phylloscirpus acaulis*. According to the ICBN (Greuter et al., 2000: Art. 9.9) part of Philippi's specimen has to be designated as the lectotype. As it is difficult to decide which part of the type corresponds with Philippi's superficial description of *Scirpus deserticola*, we have selected the lectotype so as to preserve the current usage of the two names (Greuter et al., 2000: Rec. 9A.5). The type of *Phylloscirpus deserticola* is part A on the herbarium specimen SGO 046286, located at the lower left side of the sheet.

Representative specimens examined. ARGENTINA. **Jujuy:** Humahuaca, Mina Aquilar, Mina Esperanca, vega 106, 4 Mar. 1997, B. Ruthsatz & B. Erschbamer 9797 (US). BOLIVIA. **La Paz:** Murillo, 1 km al N (abajo) de la represa del Lago Zongo, 21 Jan. 1987, J. C. Solomon 15819 (GENT). CHILE. **Antofagasta:** El Loa, Río Putana, 19 Mar. 1992, B. Ruthsatz 8347 (GENT). ECUADOR. **Tungurahua:** 2.4 km along Angamarca road from Latacunga–Mana road, 26 July 2001, S. Laegaard et al. 21478 (GENT). PERU. **Ancash:** Carhuaz, Huascarán National Park, lateral valley of Quebrada Ishinca, 12 Feb. 1985, D. N. Smith et al. 9471 (GENT, ISC).

Phylloscirpus boliviensis (Barros) Dhooge & Goetghebeur, comb. nov. Basionym: *Scirpus boliviensis* Barros, Darwiniana 11: 764. 1959. TYPE: Bolivia. Potosí: Quijarro, alt. 4350 m, 27 Feb. 1953, E. Petersen & J. P. Hjerting 1043b (holotype, C; isotype, US). Figure 1C, E.

Note: The label of the isotype mentions only Hjerting as collector and 1043 as the collector number. Other label data are identical to the label on the holotype specimen.

Small herb, 2–4 cm tall; rhizomes erect, branching; culms 1–4 cm × 0.4–0.6 mm, bluntly trigonous or terete below the inflorescence, glabrous. Leaves green, shorter than the culms; leaf sheath 2.5–4 mm long, brown; leaf blade 4–7 × 0.3–0.4 mm, glabrous; leaf tip muticous, orange or brown; ligule absent. Inflorescence always a single, terminal spikelet, globose, 2–3 mm diam. (Fig. 1C); bracts absent. Proximal glume 2 mm long, bract-

like, with a small, pale awn, red-spotted (tannin idioblasts), subtending a flower; other glumes 0.8–1 mm long, obtuse, with tannin idioblasts; flowers bisexual; stamens 2; style branches 2 or 3; perianth not developed. Fruit 1.2–1.6 × 0.7–1.2 mm, ovate, plano-convex, brown, reticulate, shiny (Fig. 1E).

Habitat and distribution. Often growing in dense cushions of *Distichia muscoides* Nees & Meyen (Juncaceae) in páramo or puna vegetations, 4190–4800 m elevation, from Bolivia, Chile, Colombia, Ecuador, and Peru.

Phenology. Noted flowering in February through May and October.

The assignment of *Scirpus boliviensis* to *Phylloscirpus* is at first not very obvious. *Phylloscirpus acaulis* and *Phylloscirpus deserticola* have a number of features in common such as a head of spikelets (Fig. 1A, B), the ovate shape of the fruit with a basal constriction, and the presence of the scabrid, bristle-like perianth segments. However, these characters cannot be found in *Scirpus boliviensis*. On the contrary, this species is morphologically very reduced, and so the number of available characters is limited. Within the tribe Scirpeae, *Scirpus boliviensis* differs from related genera such as *Amphiscirpus*, *Oreobolopsis*, *Trichophorum*, and the new genus *Zameioscirpus* (Dhooge et al., 2003) by the absence of a ligule, which is a useful diagnostic character within the tribe (Camelbeke & Goetghebeur, 1999). *Scirpus boliviensis* also morphologically resembles *Eleocharis*, but the latter has very reduced leaf blades.

Our initial idea was to create a new, monotypic genus for *Scirpus boliviensis*. However, a number of arguments can be given to put the species in *Phylloscirpus*. The three species all have eligulate leaves, their glumes have numerous tannin idioblasts visible as red spots, and the inflorescence of *Phylloscirpus deserticola* can also be reduced to one single spikelet (B. Ruthsatz & B. Erschbamer 9797, US). Significant additional support is given by the phylogenetic analysis discussed below.

Representative specimens examined. BOLIVIA. **Oruro:** Sajama, unos 4 km del pueblo, subiendo el valle del río Sururia, 10 Apr. 1995, S. Beck 22360 (GENT, LPB). CHILE. Sümpfe der Puna um den Lago Chungará, 5 Mar. 1927, C. Troll 3175 (B). COLOMBIA. **Arauca:** Sierra Nevada del Cocuy, Cabeceras de la Quebrada El Playón, Patio Bolos, 1.5–2 km al E-NE del Alto Cusirí, 8 Mar. 1973, A. M. Cleef 8941A (U). ECUADOR. **Pichincha:** páramo of Volcán Cayambe, ascent to refugio on N side, 23 Oct. 1995, B. Øllgaard 1208 (AAU, QCA). PERU. **Ancash:** Recuay, Huascarán National Park, Quebrada Queshque, lateral valley toward Rio Pachacoto, 18 Mar. 1986, D. N. Smith et al. 11828 (GENT).

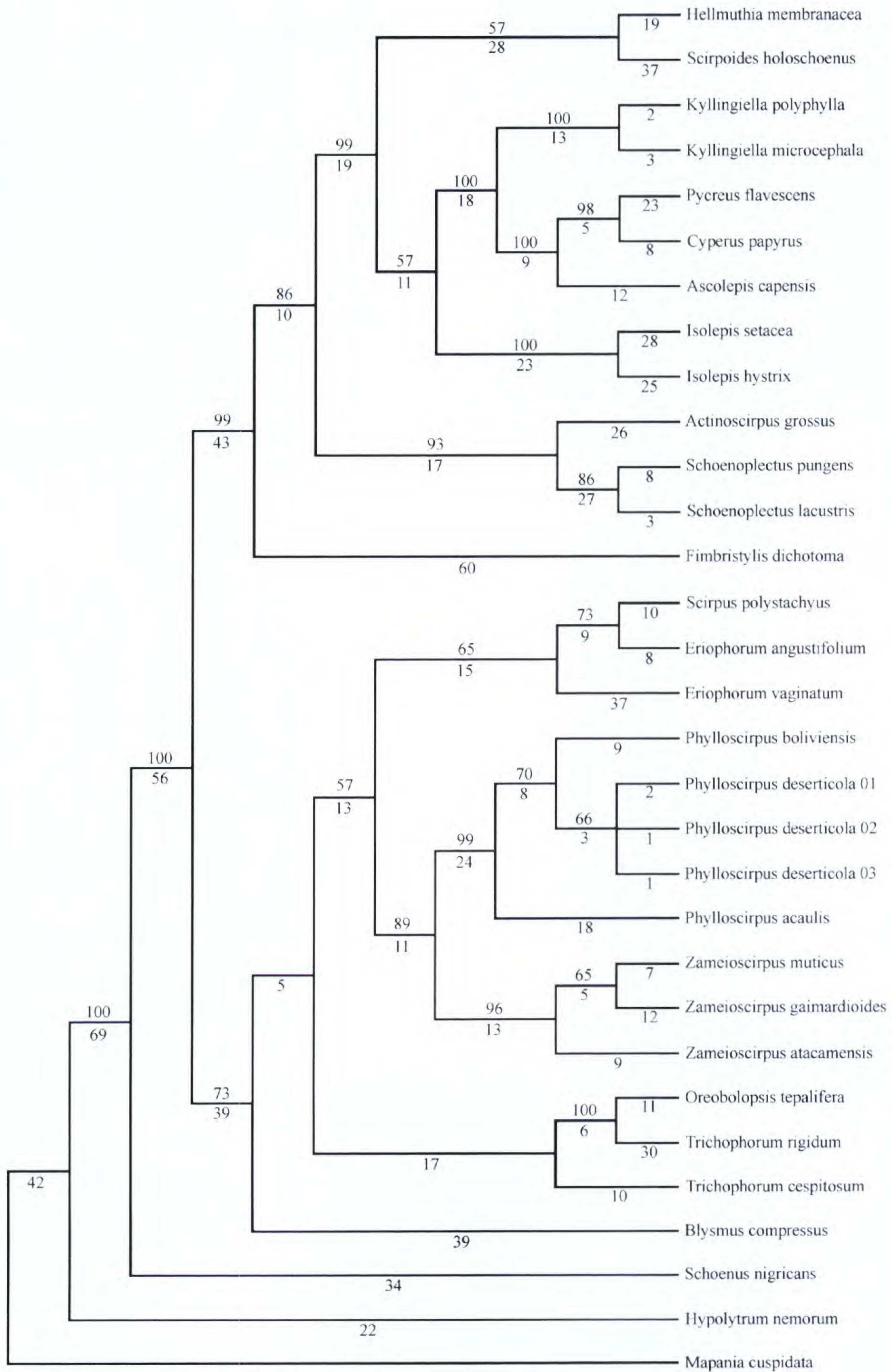


Figure 2. One of the two most parsimonious trees derived from *rbcL* and *trnL-F* data. Branch lengths are shown below the branches, and bootstrap percentages are shown above.

PHYLOGENETIC ANALYSIS

The data matrix has 354 parsimony-informative characters. Analysis of equally weighted characters produced two trees of length = 1072 steps, with consistency index (CI) = 0.79 and retention index (RI) = 0.85. The two trees do not differ in regard to *Phylloscirpus*, but in the position of *Trichoporum cespitosum* (bootstrap value < 50%, not indicated on tree). One of the two most parsimonious trees is shown in Figure 2.

The molecular analysis (unpublished) confirms the isolated position of *Phylloscirpus* (bootstrap value 99%), which is well separated from other evolutionary lines, and gives us additional support to make the two new combinations. Molecular evidence places *Phylloscirpus* in the tribe Scirpeae, corresponding to the interpretations of Goetghebeur (1986) and Bruhl (1995) for the tribe, including a possible sister group *Zameioscirpus* Dhooze & Goetghebeur.

AN EMENDED DESCRIPTION OF *PHYLLOSCIRPUS* C.

B. CLARKE

Phylloscirpus C. B. Clarke, Bull. Misc. Inform., Addit. Ser. 8: 45. 1908. TYPE: *Phylloscirpus andesinus* C. B. Clarke [= *Phylloscirpus acaulis* (Philippi) Goetghebeur & D. A. Simpson].

Small, perennial and rhizomatous herbs. Leaves basal, tristichous, eligulate. Inflorescence terminal, 1 spikelet or a dense, small head of spikelets subtended by inflorescence bracts. Each spikelet has spirally arranged glumes and ca. 4 to 6 bisexual flowers. Stamens 2 or 3. Perianth segments 2 to 6, bristle-like, retrorsely scabrid, deciduous with the fruit, or perianth segments not developed; ovary di- or trimerous.

KEY TO THE SPECIES OF *PHYLLOSCIRPUS* IN SOUTH AMERICA

- 1a. Perianth segments absent . . . *Phylloscirpus boliviensis*
 1b. Perianth segments present, bristle-like 2
 2a. Inflorescence 0.9–1.5 cm long; glumes thin, membranaceous, concolorous, yellowish brown *Phylloscirpus acaulis*
 2b. Inflorescence 4–7.2 mm long; glumes brown, with thickened, yellow midnerve.
 *Phylloscirpus deserticola*

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